ETH zürich

How to play it safe in a lab

Basic Course

October 28, 2015

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Program

1. Main hazards in a laboratory
   - Part 1: chemical products
   - Part 2: other hazards
2. Risk analysis - Where to find information
3. Dealing with hazards: Minimization of risks
4. Personal Protective Equipment
5. Emergencies - How to react
6. Questions

Coffee break

10 o’clock / 11 o’clock

in Polysnack HG F-Stock

mention «how to play it safe in a lab» at the cash desk

Main hazards in a chemical laboratory: Part 1: Chemical products

Chemical products in everyday life / at work

Chemicals can be found almost everywhere, e.g.:

- cleaning agents
- solvents
- batteries
- medical products / drugs
- fuels
- matches
- photography
- …

Attention: Chemicals are also hazardous…

- fires
- burns
- chemical burns
- intoxications
- allergies
- explosions
- damages of skin or tissues
- damage of materials
- danger for the environment

Main hazards in a chemical laboratory: Part 1: Chemical products

→ Labeling

Labeling

Danger symbols

– **Labels on bottles**

SGU

Hazard and safety indications on lab doors

Labeling

Prohibition signs

Labeling

Warning signs

- On entrance doors
- On cabinets

Labeling

Mandatory signs

- On entrance doors
- On machines

Right or wrong?

Main hazards in a chemical laboratory: Part 1: Chemical products

→ How to work with chemical products in a lab

How to work with chemical products in a lab:

Fume hood

source: http://www.waldner-lab.de/de/service/galerie/fotos.aspx

Laminar flow

source: http://ssfp.unileoben.ac.at/Laminar.htm

Glove Box

source: http://en.wikipedia.org/wiki/File:Glovebox.jpg

Fume hoods

Why working in a fume hood?

- Prevent toxic, harmful or corrosive gases, vapors, dust particles, aerosols, etc from spreading into the ambient air
- Prevent formation of explosive gas mixtures inside a fume hood
- Protection against splashes and splinters

When working in a fume hood?

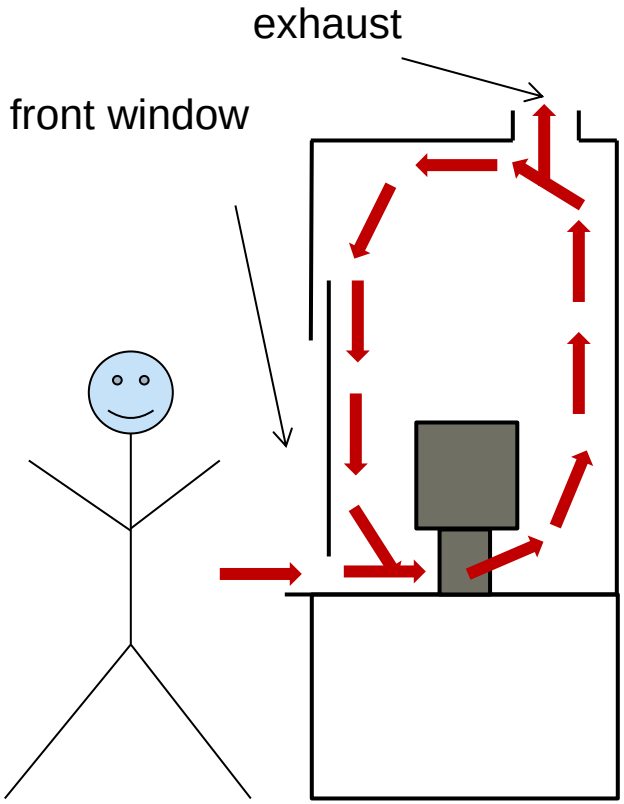
- When conducting experiments/procedures which might release harmful or hazardous gases, vapors, dust and aerosols

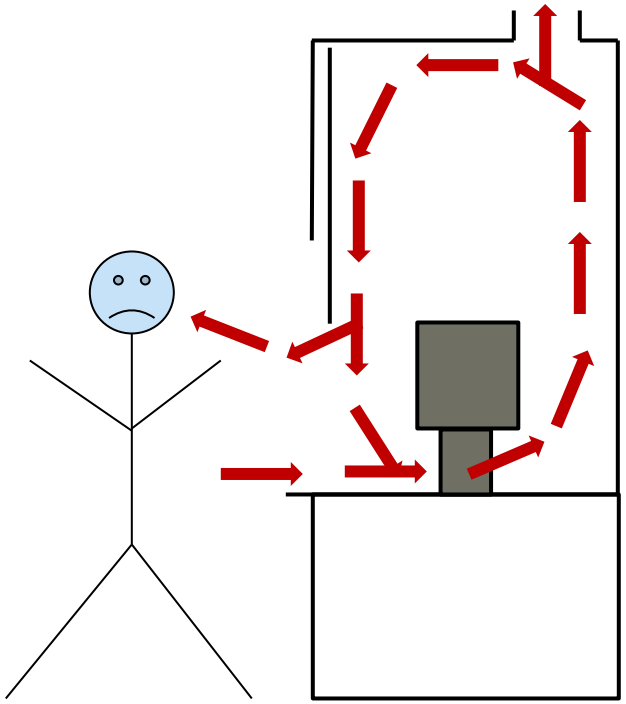
Fume hoods

Some basic rules:

- Check fume hood is **ON** (with a piece of paper)
- Only work in laboratory scale
- Always wear **PPE** such as safety glasses, labcoat (and gloves)
- Keep front window closed
- Fume hood ≠ storage place

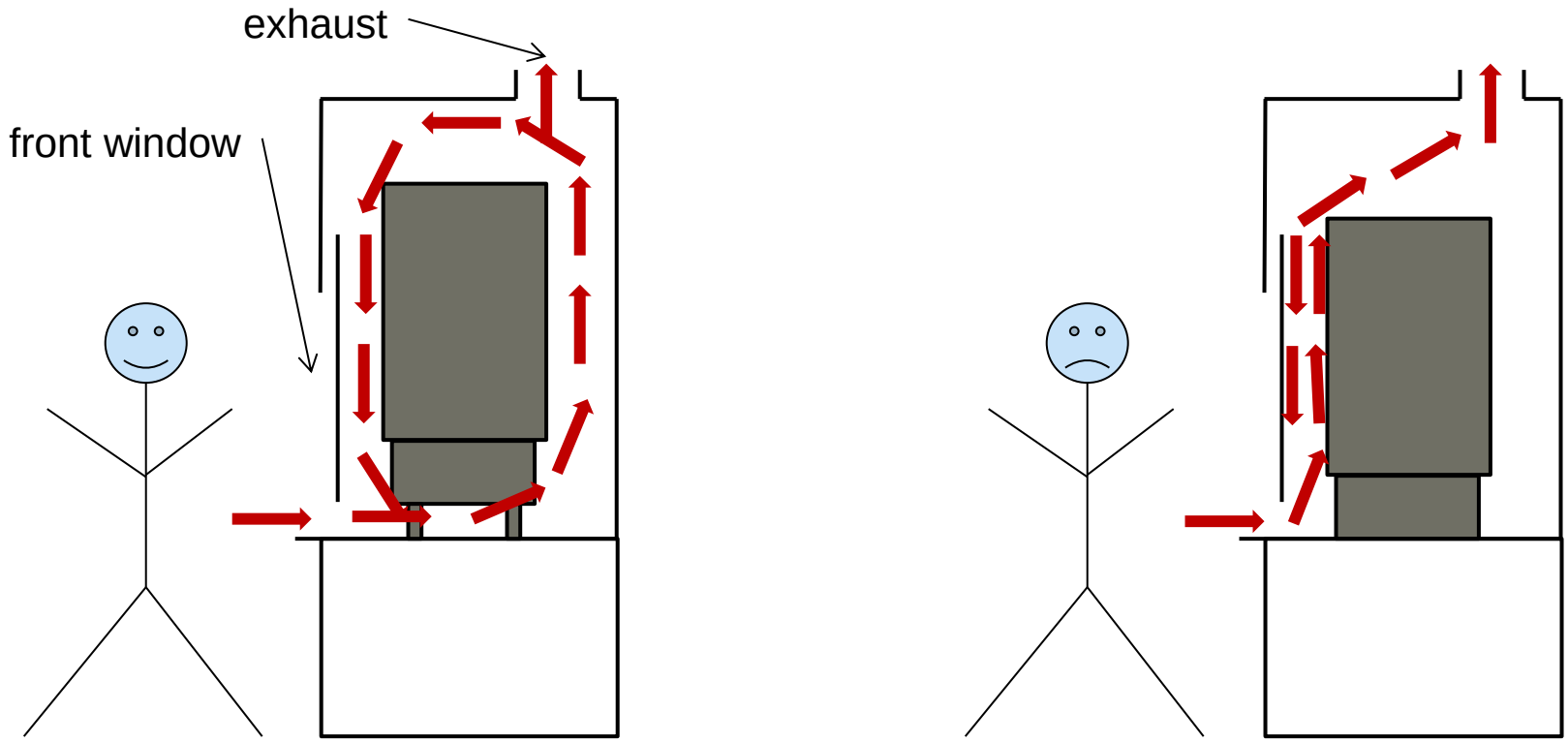
Fume hoods





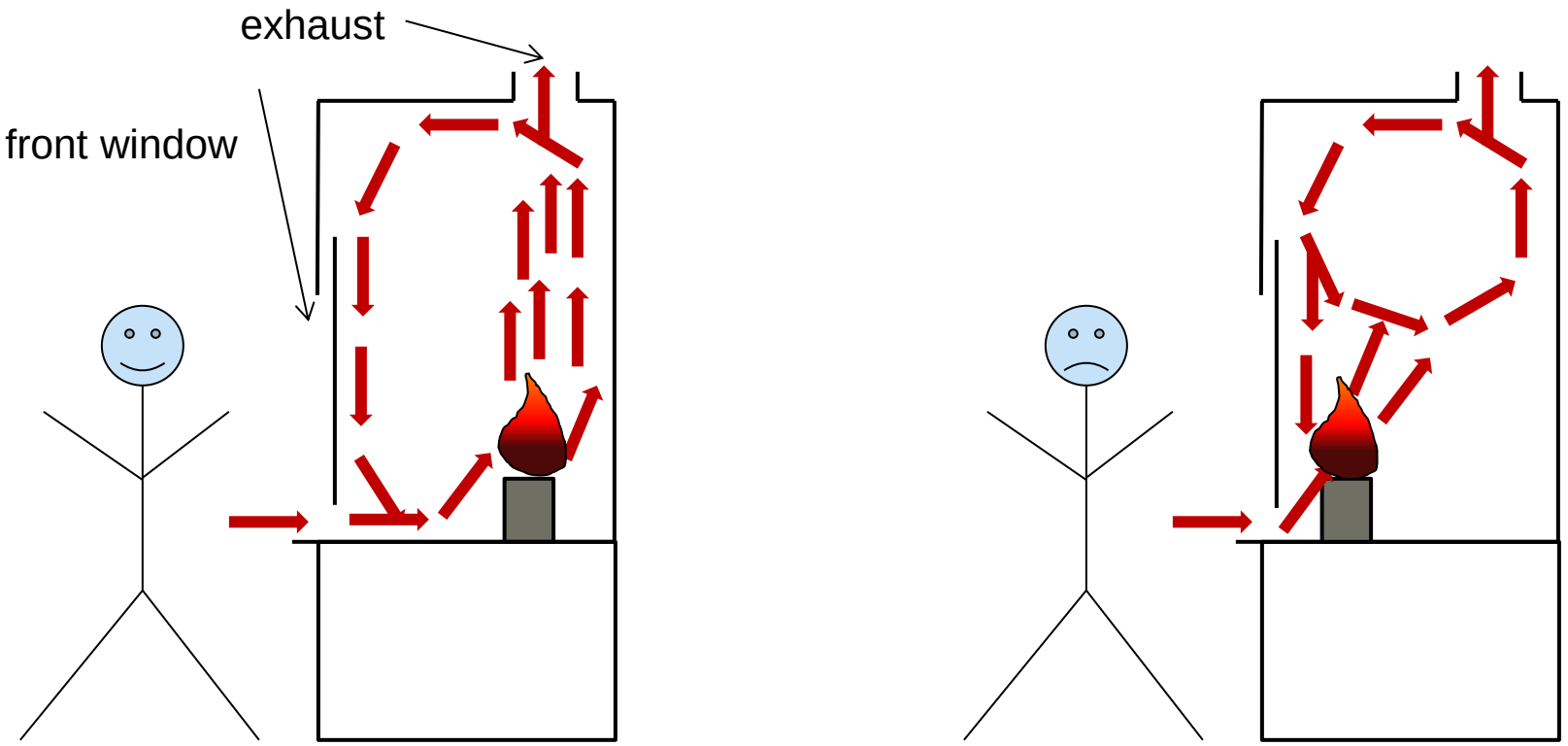
→ **Keep front window closed!**

Fume hoods



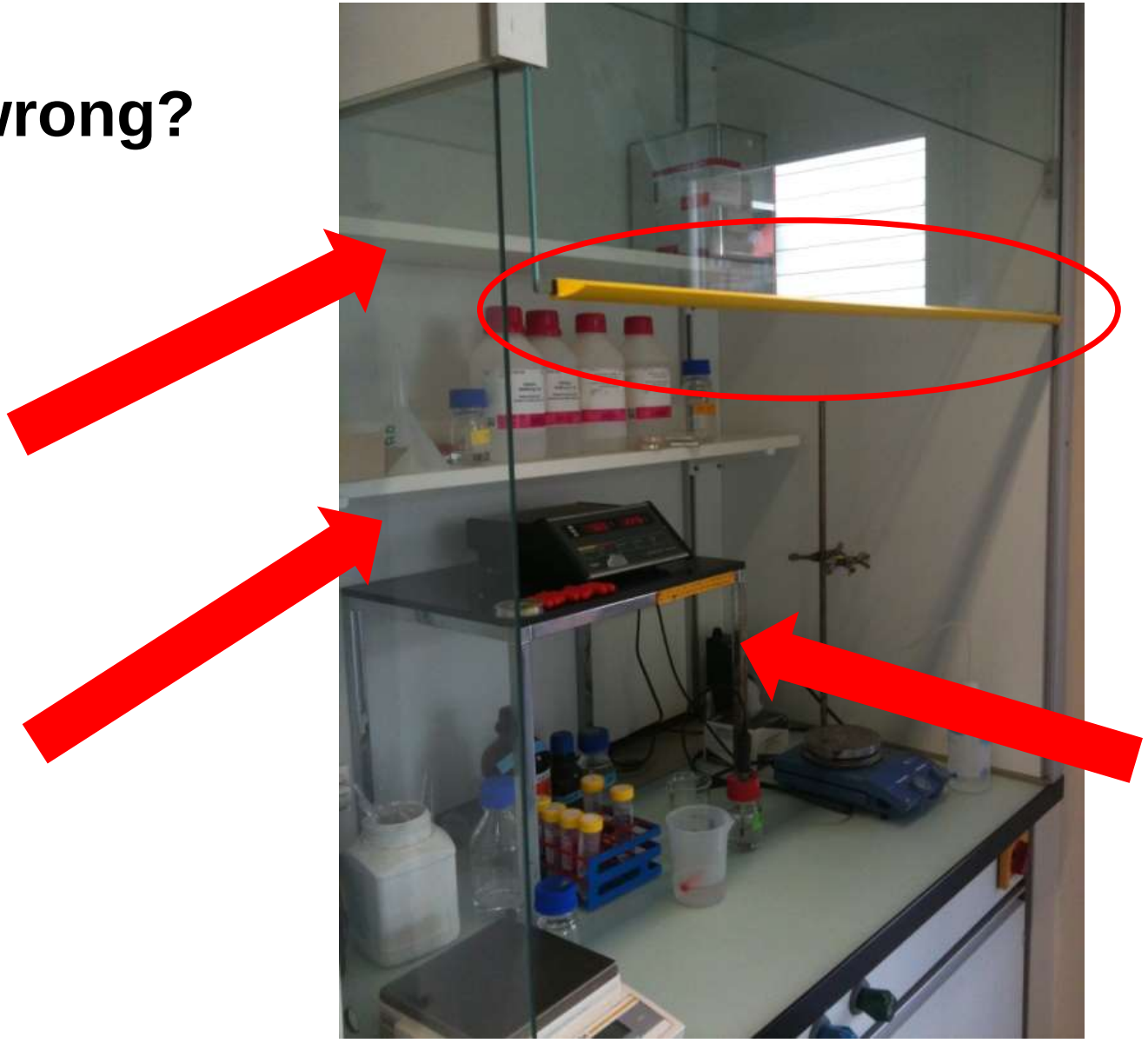
→ **Make sure that airflow / circulation is not disturbed by large equipment in the fume hood !**

Fume hoods



→ **Place heat sources in the rear part of the fume hood!**

What is wrong?



Glove box

source: http://en.wikipedia.org/wiki/File:Glovebox.jpg

What is a glove box?

- Sealed container to manipulate compounds / objects in a separate atmosphere
- Objects / substances have to be introduced into and removed via an air-lock

Glove box

When working in a glove box?

- To work with hazardous substances in a specially filtered atmosphere
- To manipulate substances in an inert gas atmosphere (e.g. argon, nitrogen)

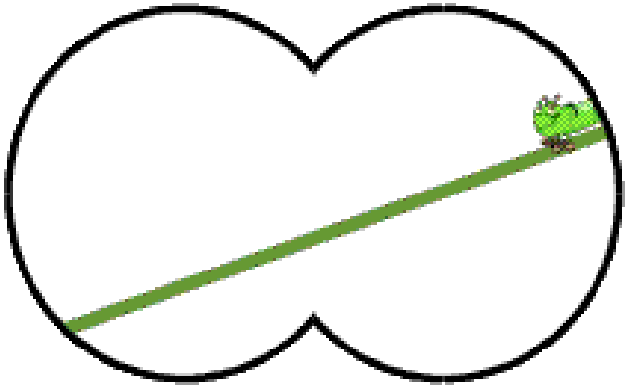
Laminar flow box

Functional principle:

- Room air is sucked in the laminar flow box and filtered (e.g. HEPA-filtration)
  → creation of a sterile atmosphere
- Laminar flow reduces turbulences of particles present in air and discharges them downward
- Recirculation of air within the box to the room

→ Laminar flow box ≠ fume hood

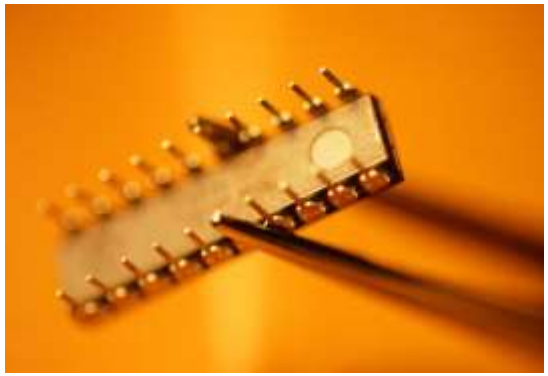
Laminar flow box



When working in a laminar flow box box?

- Need of a sterile atmosphere
  →often biological work
  →biosafety cabinets
- Need of a dust free atmosphere
  → optics
  → analytics
  → electronics

source: http://zocker0815.npage.de/gedanken.html



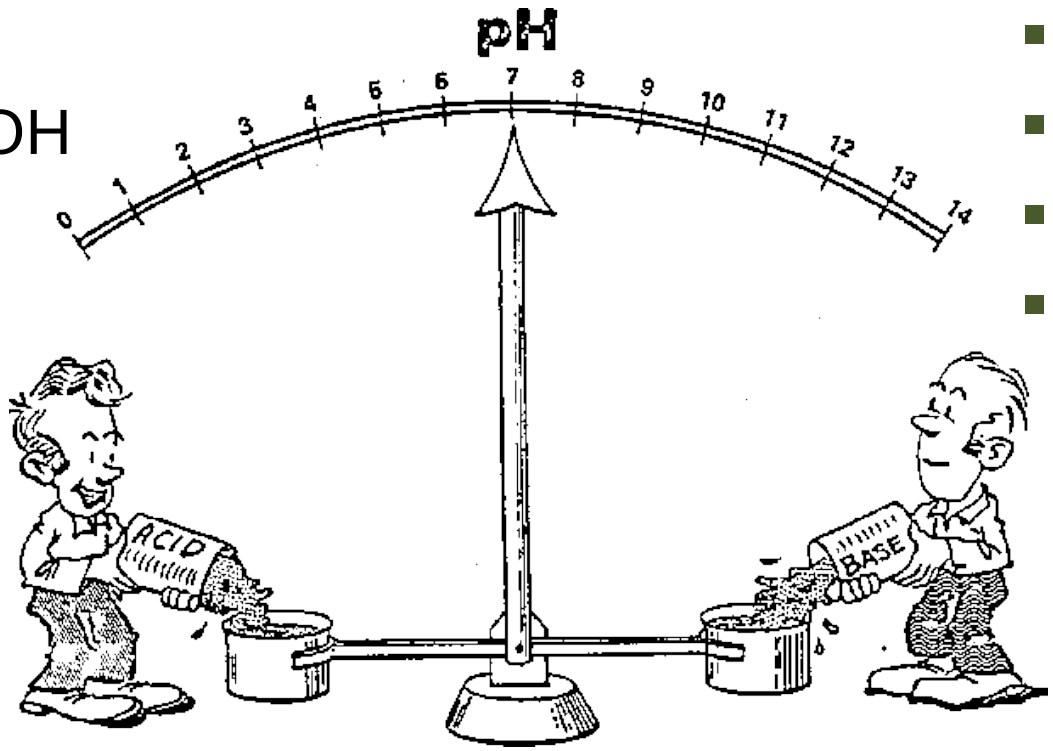
Main hazards in a chemical laboratory: Part 1: Chemical products

→ Hazardous chemicals

Acids and Bases

- HCl
- HNO_3
- H_2SO_4
- H_3CCOOH
- HF
- …

- NaOH
- KOH
- Ca(OH)2
- NH3
- H3CNH2
- …



http://nutritionalmuscletesting.com/web_images/acid_20base_20balance.gif

Chemical burn

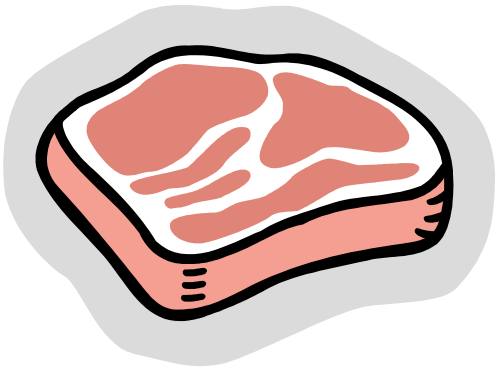
Danger:

Acids can cause chemical burns on the skin

Model: Nitric acid on meat – with and without protective gloves

Chemical burn

Observations:



- The piece of meat turns immediately white when it gets in contact with the acid
  → chemical burn
- The piece of meat protected by a glove isn`t chemically burned
- Also the glove remains intact

Chemical burn

Consequences:

→ Wear gloves and safety glasses

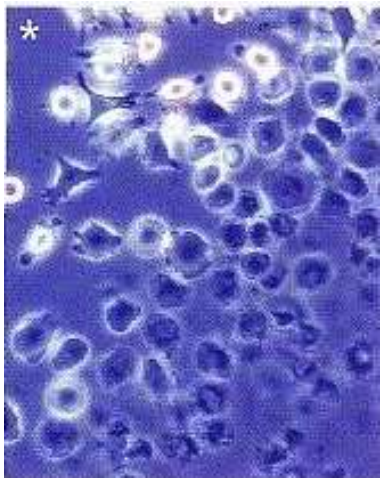
→ Work in a fume hood

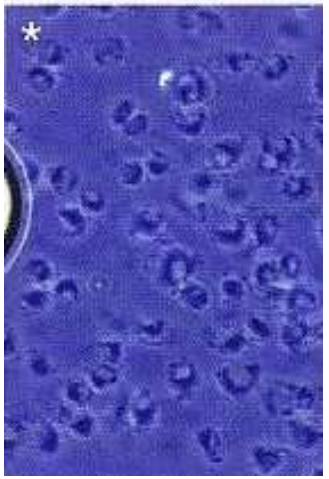
Hydrofluoric acid – HF

- Highly corrosive liquid
- *Strong contact poison*
- Chemical burn of lower tissue layers, even bones
- Symptoms of exposure may not be immediately evident
  → interferes with nerve function
  → initial chemical burns may not be painful
  → *accidental exposures can go unnoticed*
- Rule: a burn the size of your palm is fatal (40% HF)

http://www.glasmalerei.de/techniken/aetzen/ aetzen-1/index.html

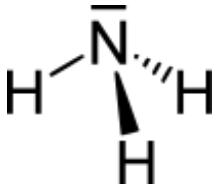
Sodium hydroxide – NaOH





- Can decompose proteins and lipids in skin, eyes …
  → chemical burn
- Dissolution of solid NaOH
  → exothermic, resulting heat can cause heat burns or ignite flammables
- Exothermic reaction with acids
- Corrosive to some metals, e.g. Al
  → produces flammable H_2 gas

Ammonia



- Characteristic pungent smell
- Irritating, caustic effects on eyes and skin
- Easily resorbed through the skin
- Inhalation
  → irritating / harmful effects on the respiratory system (*acute effect*)
  → respiratory disorder (*chronic effect*)
- Oral incorporation
  → severe damages of the digestive tract

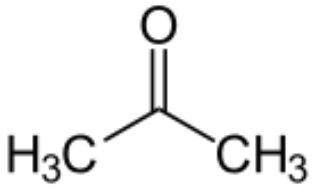
Pungent smell = first warning

SGU → ***Poisoning with ammonia occurs seldom.***

Solvents

- acetone
- acetonitrile
- dichloromethane
- ethanol
- ethyl acetate
- hexane
- tetrahydrofuran
- …

Acetone



- Degreases the skin
- Only slightly toxic in normal use
- Most hazardous property: *extreme flammability*
- Temperature greater than flash point
  → air/acetone mixtures (97.5/2.5-vol% – 87.2/12.8-vol%) may explode or cause a flash fire
- Vapors can ignite sources and flash back
- Static discharge may ignite acetone vapors

Solvents

Danger:

Damage of material or deleterious effects on skin

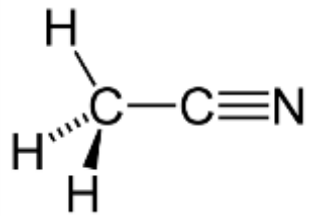
Consequences:

Skin protection and care comprises:

→ Use of gloves

→ Use of hand cream

Acetonitrile

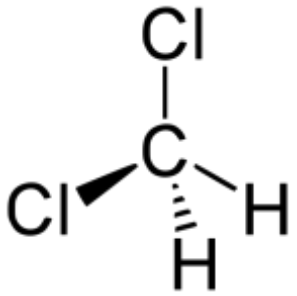


- Metabolized to *hydrogen cyanide*
  → the onset of toxic effects is delayed about 2–12 hours
- *Symptoms:* breathing difficulties, slow pulse rate, nausea, and vomiting
  → *Serious cases:* convulsions and coma, followed by death from respiratory failure

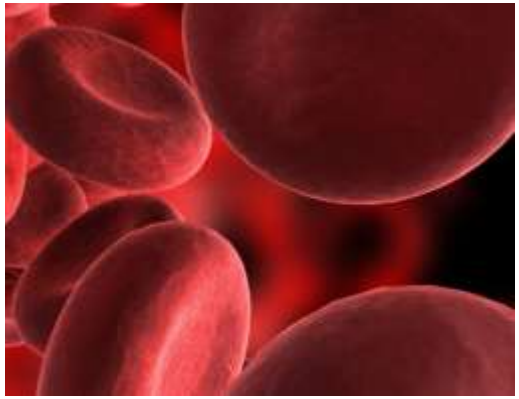
source:
http://www.topfruits.de/html_datasheet.php?products_id=1810

source:
http://www.hoio.ch/index.php?id=1103

Dichloromethane (DCM)

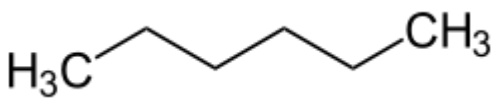


- High volatility
- *Acute inhalation hazard*
- Metabolized to carbon monoxide
  → eventually CO poisoning
- Acute exposure by inhalation
  → optic neuropathy, hepatitis



- Prolonged skin contact
  → possibly dissolving of the fatty tissues in skin
  → skin irritation or chemical burns
- DCM *might be carcinogenic*

Hexane



- *Acute toxicity:* low, mild anesthetic
  → first a state of mild euphoria
  → followed by somnolence with headaches and nausea
- *Chronical toxicity:* well known in humans
  → Extensive peripheral nervous system failure
  Initial symptoms: tingling, cramps in the arms and legs
  then: general muscular weakness
- Suspected of damaging fertility

Tetrahydrofuran (THF)

- Penetrates the skin → rapid dehydration
- Serious eye irritation
- Respiratory irritation
- Greatest danger: *tendency to form highly-explosive peroxides on storage in air*

→ often inhibitor added in commercial samples
→ THF should not be distilled to dryness, because the explosive peroxides concentrate in the residue

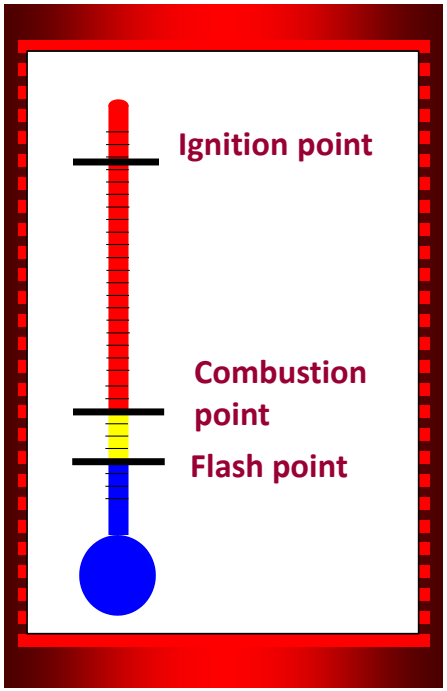
Inflammable chemicals

Danger:

Inflammable substances can ignite or be ignited and cause fires and burns

http://www.arbeitsschutzfilm.de/mediathek/youtube/explodierende-gasflaschen-auf-der-autobahn-video_984c63331.html

Inflammable chemicals



Explanation:

Flash point: Vapors are ignited by an ignition source
combustion stops after removal of the ignition source

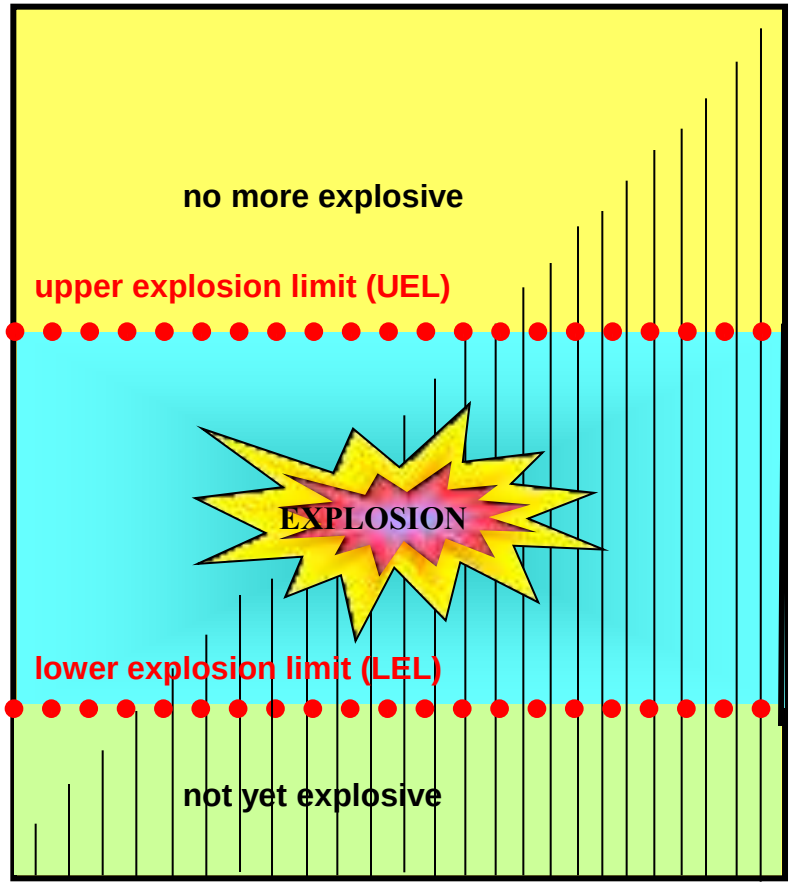
Combustion point: Vapors are ignited by an ignition source
continue burning after removal of the ignition source

Ignition point: Vapors ignite spontaneously

Inflammable chemicals

Explosive mixtures:

substance	LEL [%vol]	UEL [%vol]
ether	1.7	36.0
ethanol	3.4	15.0
gasoline	0.6	8.0
hydrogen	4.0	75.6



No smoking

No food and drinks in a lab

What is wrong?

What is wrong?

What is wrong?

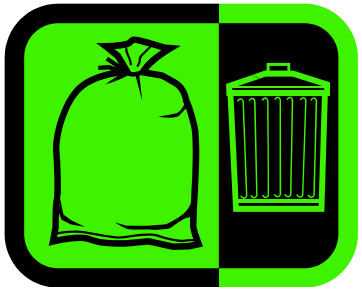
SGU

Main hazards in a chemical laboratory: Part 1: Chemical products

→ Waste disposal

Disposal of “normal” waste

- Minimize waste
- Separate waste
  - Paper and cardboard
  - Glass and bottles
  - PET
  - Metal
  - Electrical waste
  - Used CD/DVDs



Disposal of hazardous waste

→ the smellier the waste the more it needs to be collected separately

- Minimize waste
- Use official containers
- Separate waste
  - Acids
  - Bases
  - Mercury
  - Chlorinated solvents
  - Non-chlorinated solvents
  - …

Disposal of hazardous waste

- CNB
  Wednesday: 09 - 11 am
  Contact: Martin Frei
  martin-frei@ethz.ch
- HCI
  Monday - Friday: 2 - 4 pm
  Contact: Guido Krucker
  guido-krucker@ethz.ch
- HPL: once per month

Campus Zentrum

Science City, Campus Hönggerberg

Waste?

Waste!

source: http://sprachstammtischemuenchen.jimdo.com/blog-latest-news/all-blog-posts/

Main hazards in a chemical laboratory: Part 1: Chemical products

→ Apparently harmless substances

Apparently harmless substances: really harmless ↔ inherent dangerous

Example 1: Nitrogen (N_2)

- The air consists of almost 80% nitrogen
- Nitrogen is not flammable, not toxic, odorless

→ absolutely harmless???

Liquid nitrogen

Danger:

Apparently harmless substances

→ Risk is underestimated

Model: Rose in liquid nitrogen

SGU

Liquid nitrogen

Observations:

- The rose cracks after removing it from the liquid nitrogen bath (-196 °C)
- Even very cold substances can be liquid → cryogenic liquids

Liquid nitrogen

source: http://www.phys.ethz.ch/phys/dep/dienste/techbetr/verfluss/

Consequences:

→ Avoid direct contact to cryogenics (also to tubing)

→ Wear safety glasses and special gloves

Liquid nitrogen

Yet another danger:

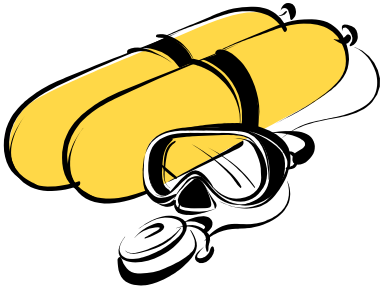
source: BG RCI

- 1 Liter of liquid nitrogen
  → about 700 liter of gas!
- Displaces oxygen (O_2) from the air

content of O_2 in the air	What happens?
ca. 21%	Normal ambient air
< 16%	Expired air Loss of performance
< 11%	Fire gets extinguished
< 10%	Sudden loss of consciousness
< 6-8%	Death by asphyxiation within minutes

Apparently harmless substances: really harmless ↔ inherent dangerous

Example 2: Compressed Air



Gas cylinders

Danger:

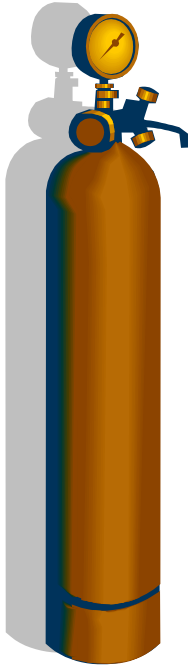
Underestimation of „secondary“ hazards

Model: Valve of compressed air cylinder breaks

source: Schweizerischer Feuerwehrverband

SGU

Gas cylinders



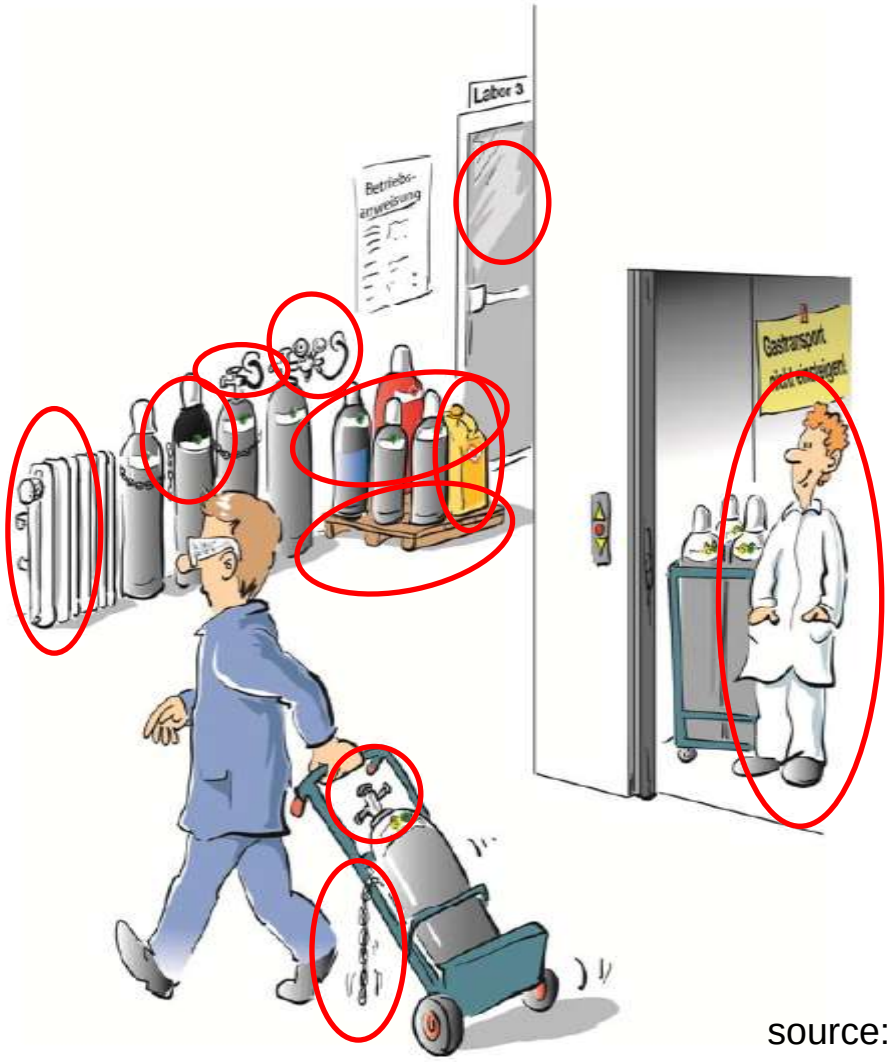
Consequences:

- → Use personal protective equipment
- → Avoid heat sources next to gas cylinders
- → Secure gas cylinders against falling
- → Always use the correct pressure reducing valve
- → When not in use: safety cap
- → Never use „brute-force“ when handling valves
- → Never lubricate valves
- → Label empty and defective cylinders

What's wrong?

source: BG RCI

What's wrong?



source: BG RCI

Main hazards in a chemical laboratory: Part 2: Other hazards

Some other common hazards in a (chemical) lab:

- Lasers
- Heat sources
- Magnetic fields
- Biological agents (pathogens, GMO)
- Centrifuges
- High voltage, power current
- Vacuum or high pressure
- Sharps and glassware
-

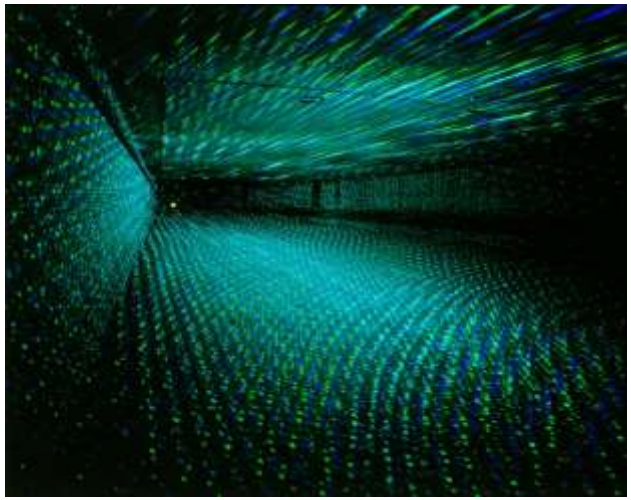
Main hazards in a chemical laboratory: Part 2: Other hazards

→ Lasers

Laser *(non-ionising radiation)*

4 Classes:

- ***Class 1***
  - - **Safe** under all conditions of normal use
- ***Class 2***
  - - Visible-light lasers
  - - **Fairly safe**
    blink reflex will limit the exposure to no more than 0.25 seconds (if not viewed through optical instruments)
  - → ***Do not stare into beam***



source: luminapolis.com/en/2010/01/deutsche-nationalbibliothek-interaktive-laserskulptur/

Laser *(non-ionising radiation)*

Class 3

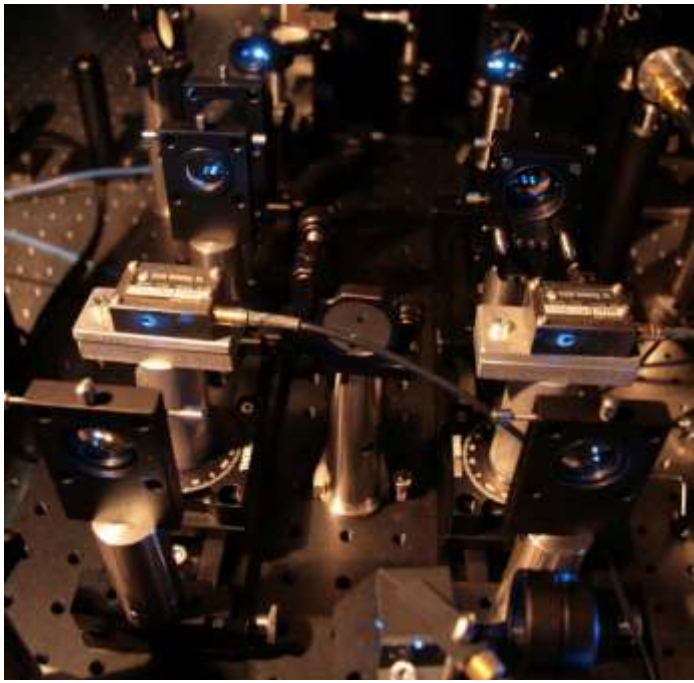
Class 3 R

- - Is considered safe if handled carefully, with restricted beam viewing
- - The maximum permissible exposure can be exceeded → **low risk of injury**

Class 3 B

- - Hazardous if the eye is exposed directly, in some cases it can be hazardous for the skin

→ ***Wear protective eyewear***

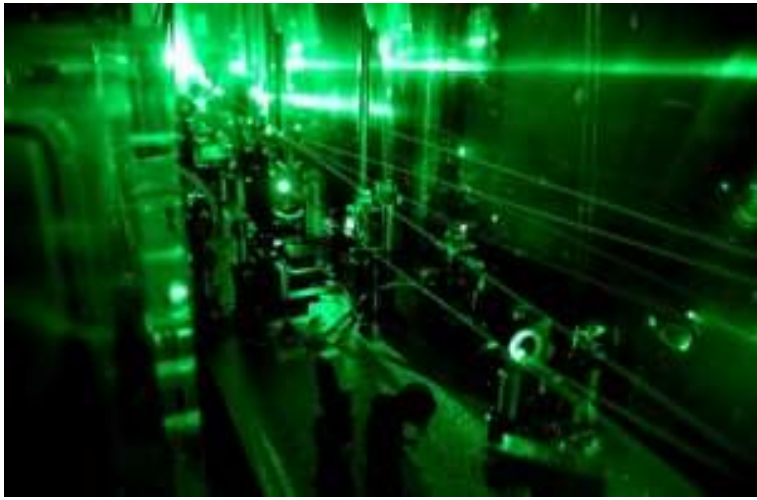


source : www.dresden-forscht.de/index.php?id=49

Laser *(non-ionising radiation)*

Class 4

- - Can cause permanent eye damage and burn the skin as a result of direct or diffuse beam viewing.
- - May ignite combustible materials, and thus may represent a **fire or explosion risk**
- → ***Wear protective eyewear***



Laser Labelling

Warning sign

Indication of laser class and instructions

Additional labelling – laser classes 3B and 4

Laser data

Laser medium	
Wave length	
Duration of emission	
Radiation efficiency	
Radiation energy	

Warning lamp
in front of the door
=
DON`T ENTER.

source: http://www.goebel-laser.de/html/warnen.html

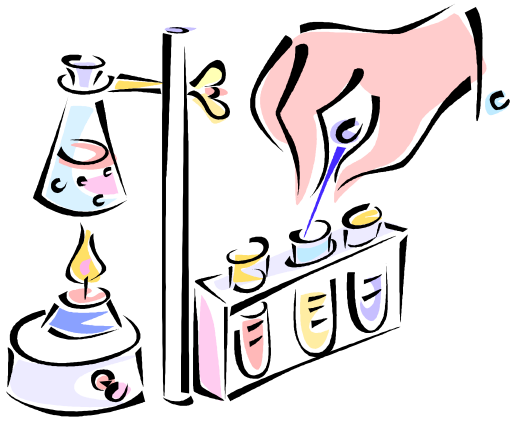
source: http://www.laser2000.de/index.php?id=370356

Main hazards in a chemical laboratory: Part 2: Other hazards

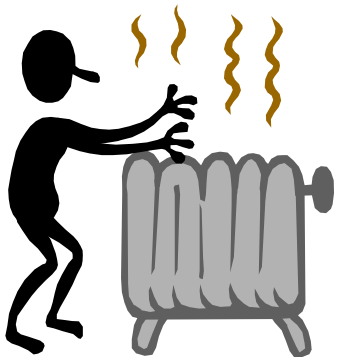
→ Heat sources

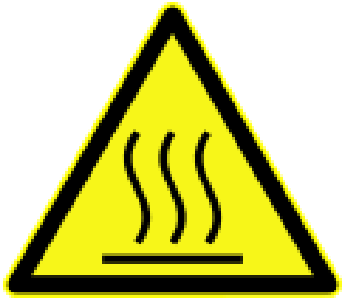
Heat sources in a lab

- open fire (Bunsen burner)
- hotplate
- sand bath
- oil bath
- light sources (Lasers, light bulbs)
- …



Heat sources in a lab





Basic rules:

- Don’t touch hot surfaces (this rule seems to be quite obvious, but…)
- Hot surfaces look the same as cold surfaces
  → mark them with a warning sign
- Check electric installation (temperature control, etc.) regularly

Heat sources in a lab

Some more rules:

- Caution: no water near oil bathes!
  → preferably use DrySyn systems
- Keep flammables and gas cylinders away from heat sources
- Beware of secondary hazards (e.g. Laser beam, open gas,…)

source: http://www.dechema.de/Presse/Pressemitteilungen/Archiv/2008/42_2008.html

Main hazards in a chemical laboratory: Part 2: Other hazards

→ Magnetic fields

Magnetic fields

Hazardous effect depends on the strength of the magnetic field

Field intensity	description	Restrictions / no access for
0.5 mT / 5 G	Maximal field authorized for public, wearers of pacemakers or implants, pregnant women	Public, wearers of pacemakers or implants, pregnant women
3 mT / 30 G	Field starting from which ferromagnetic objects can be dragged by the field	Any ferromagnetic object (e.g. tools)
0.2 T / 2 kG	Field starting from which the access is unauthorized without medical recommendation.	Any, except with medical recommendation

Magnetic fields

Protective measures

→ Mark the dangerous zone
(line on the ground)

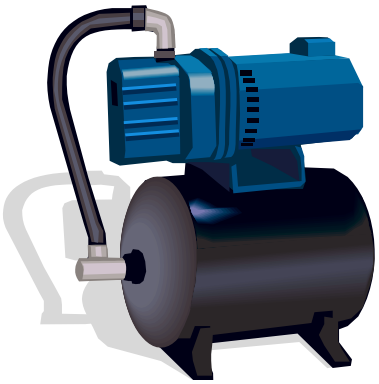
→ Keep out if you are not authorized

→ Warning signs, prohibitions

Main hazards in a chemical laboratory: Part 2: Other hazards

→ Vacuum

Vacuum



- Implosion
- Protective measures: shielding windows, safety glasses , etc.
- Never evacuate cylindrical or cubic glassware (only round flasks)
- Make sure that equipment is vacuum-proof

Main hazards in a chemical laboratory: Part 2: Other hazards

→ High pressure

High pressure

- Explosion
- Hazard depends on physical condition:
  200 bar liquid (e.g. HPLC) less hazardous than 200 bar gas pressure (e.g. N_2 gas bottle)
- Make sure that equipment is high-pressure-proof
- Reactions / procedures with more than 10 bar gas pressure

→ **work in high pressure labs**
→ **inform SSHE**

Main hazards in a chemical laboratory: Part 2: Other hazards

→ Sharps

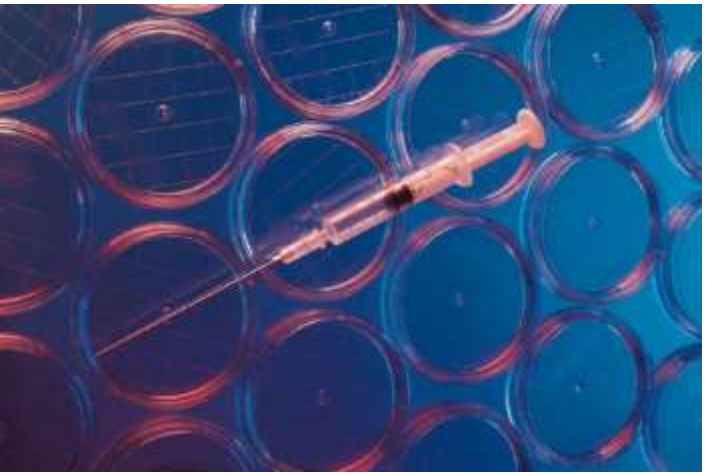
Sharps: Syringe needles, scalpels

- Injuries
  Potential source of contamination with chemical, biological, infectious, radioactive material
- Needle-stick injuries
  Often occur when recapping needles
  → immediately dispose of syringe and needle
  → Never place any sharps in the ordinary trash bin
- Common causes for lacerations
  → Picking up contaminated pieces of broken glassware
  → Working with damaged glass equipment

Special Sharp Containers

- Unbreakable, puncture-proof, sealable
- Place sharps container within easy reach
- Don’t walk around when carrying sharps
- Dispose of sharps immediately after use.
- Don’t overfill sharps container
- Seal it when it is ¾ full and take it to the hazardous waste disposal station.

Contaminated Sharps



Sharps contaminated with infectious material:

Have to be inactivated before disposal

→ collect in autoclavable sharps containers

→ autoclave

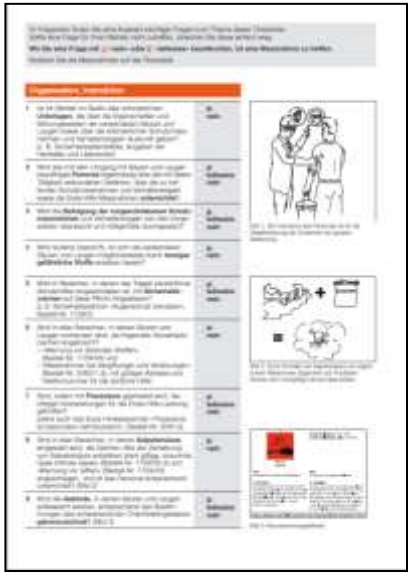
→ dispose

What is wrong?

Risk analysis – where to find information?

For standard procedures: Checklists

- All important issues to be checked on one list
- For general procedures and hazards: available from the SUVA (www.suva.ch)



Where to find information on specific hazards

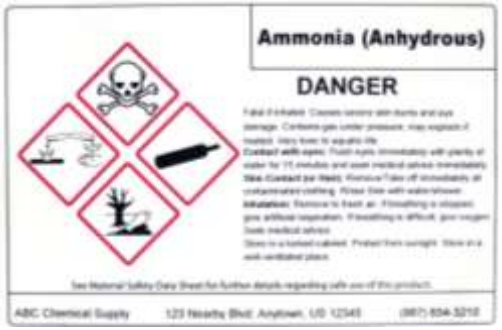
- Machines / equipment
  → user's manual, supplier

- Laboratory hazards
  → DGUV "Working Safely in Laboratories – Basic Principles and Guidelines"
  http://bgi850-0.vur.jedermann.de/index.jsp

  → ETH SSHE factsheets, guidelines, concepts
  https://www.ethz.ch/services/de/service/sicherheit-gesundheit-umwelt/dokumente.html

Where to find information on chemicals

- On the product label on the bottle / can



- In the MSDS (Material Safety Data Sheet)
  - Substance, production company
  - Detailed contents
  - Possible hazards
  - First aid measures
  - Fire fighting measures
  - Handling and storing
  - Personal protective equipment (PPE)
  - Physical and chemical prope
  - Toxicology
  - Ecotoxicology
  - Transportation
  - Legal aspects

Where to find information on chemicals

- Online databases
  → e.g. GESTIS (also available as Apple and Android app)

GESTIS

- For non-commercial new chemicals: scientific publications

Dealing with Hazards: Minimization of Risks

Dealing with hazards / minimization of risks

Before the experiment:

- Check and consider safety instructions
- Define exactly the work flow and procedures
- Check experimental setup

Minimization of risks

During the experiment:

- Apply safety measures
- Use protective equipment
- Protect people, environment and values

Minimization of risks

After the experiment

- Clean up your workplace, sort / recycle your waste
- Turn off all media (cooling water, electricity, gas, etc.)

In general: think before you act

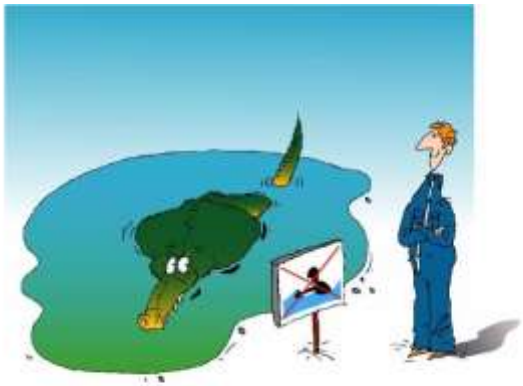
In case of doubts or questions: contact an expert

Dealing with hazards: The STOP concept

Technical measures

Strategic measures

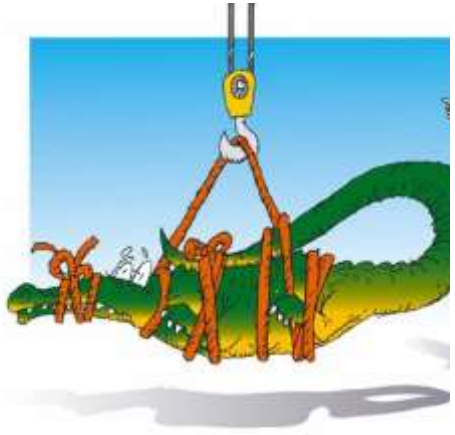
Organizational measures



Personal protective equipment

Decreasing efficacy

STOP: Strategic measures



- Check if there are less hazardous products available (substitution)

  → e.g. heptane or pentane instead of hexane

- Check for safer procedures

  → e.g. “DrySyn” instead of oil bath

STOP: Strategic measures

- Check for “hidden” / secondary hazards

  → e.g. laser class 4: produces not only light, but might also cause fire

- Preferably use small quantities of chemicals

  → e.g. small-scale reactions; large scale only with optimized parameters

STOP: Technical measures

- Separate work areas

  → some work (e.g. radioactivity, biohazard) need special labs

- Gas detection

  → when working with hazardous gases or liq. N_2 (depending on quantity)

  → contact SSHE

STOP: Technical measures

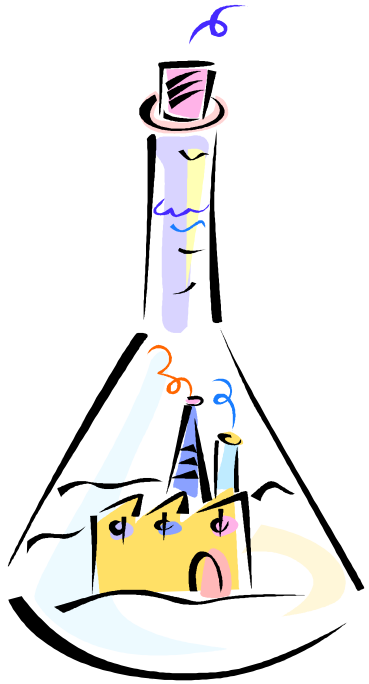
- Shielding

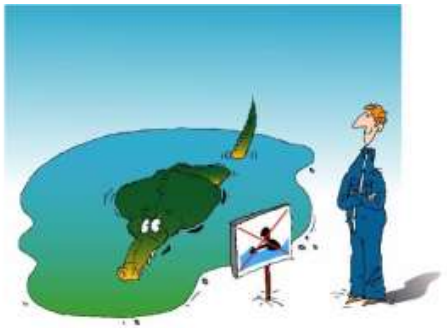
  → e.g. shatter protection shields, lead shields for gamma-radiation

- Ventilation / fume hood / local exhaust ventilations

  → no hazardous work in non-ventilated areas

  → handling harmful chemicals, soldering





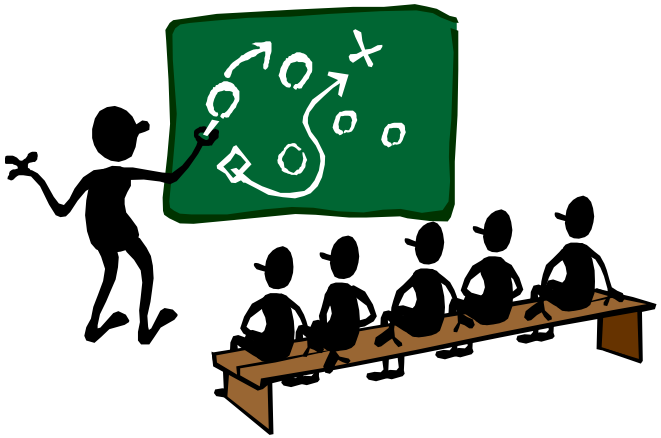
STOP: Organisational measures

Instruction / training / SOP's

→ Mandatory (supervisor is responsible for instruction / training, employees have to work according to them)

→ Also for students, visitors, maintenance personnel, etc.

→ Set up SOP's for specific procedures



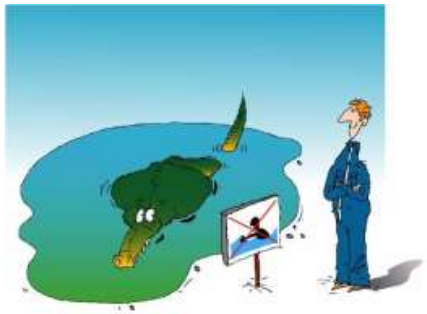
Courses and seminars organized by SSHE

- gas cylinders
- biosafety
- laser seminar
- radiation protection
- disposal of hazardous waste
- working with nanoparticles
- fire fighting training
- etc.

SSHE course calendar:

https://www.ethz.ch/services/de/service/sicherheit-gesundheit-umwelt/aus-und-weiterbildung/kurskalender.html

STOP: Organisational measures



Labels / signs

→ Hazard symbols, warning signs, obligations, access restriction
(available from the SSHE → stickers@ethz.ch)

→ Employees have to know what they mean and how to behave

→ Use signs when necessary **but never warn of non-existing hazards!**

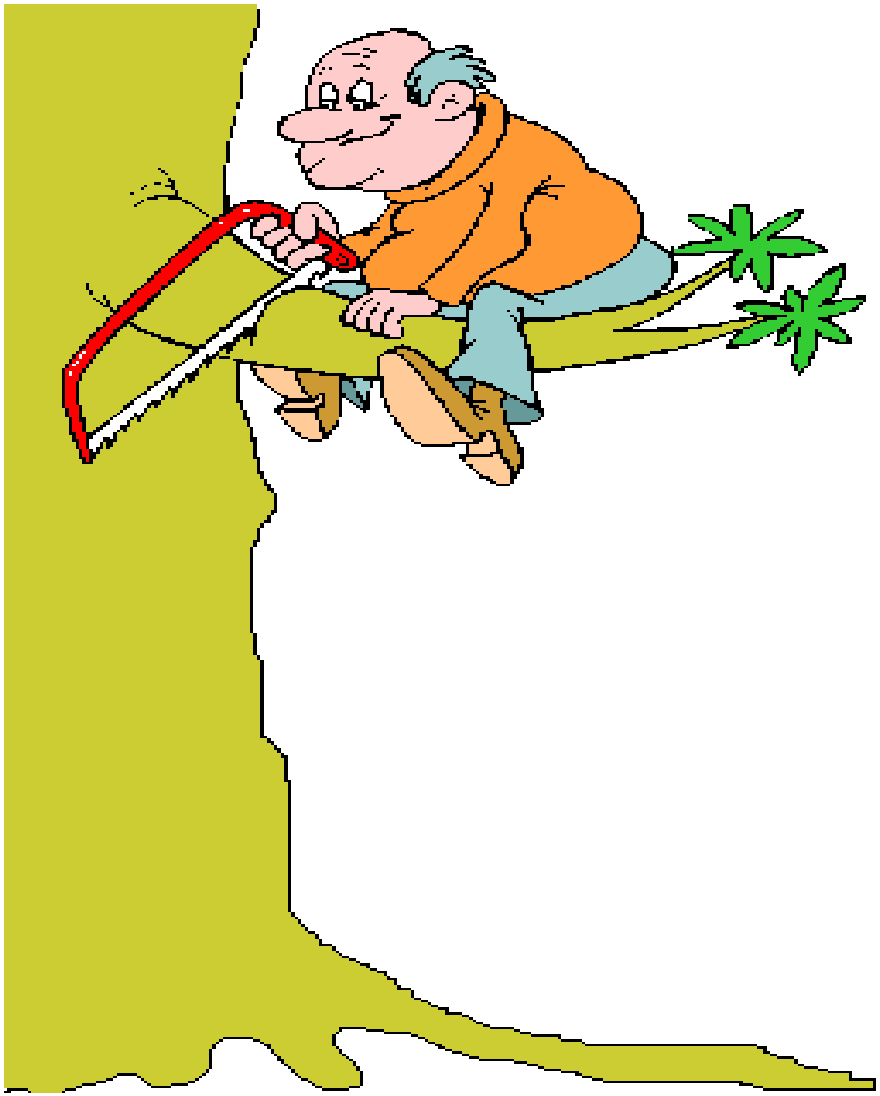
Lab safety – some general rules

- Entrance only for people working in the lab
- No food and drinks in the lab
- Disorder amplifies the risk → keep your working area clean
- Never do risky work alone → there must always be a second person in the same room
- „Hot things often look the same as cold things“ → be careful
- Experiments running over night → secure all media (cooling water, etc.)

source: http://nobel.scas.bcit.ca/debeck_pt/science/safety.htm

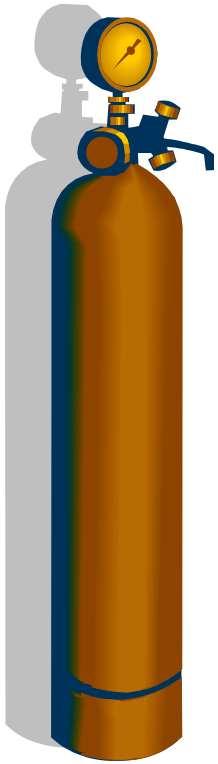
Disorder amplifies the risk

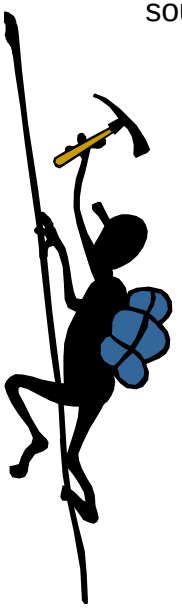
Risky work

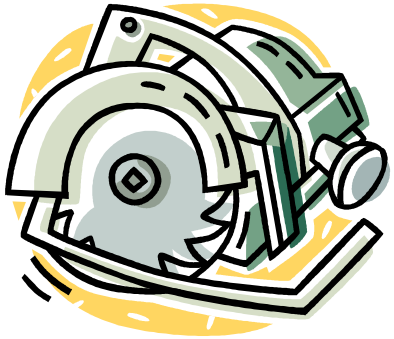


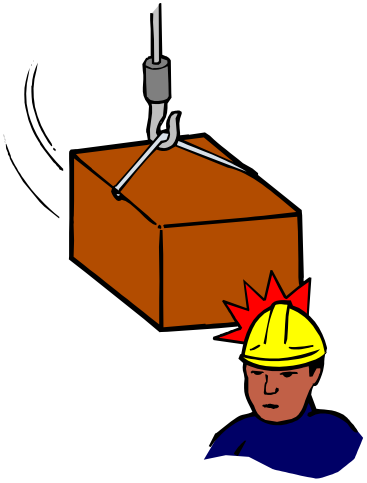
Never do risky work alone

source: http://de.wikipedia.org/

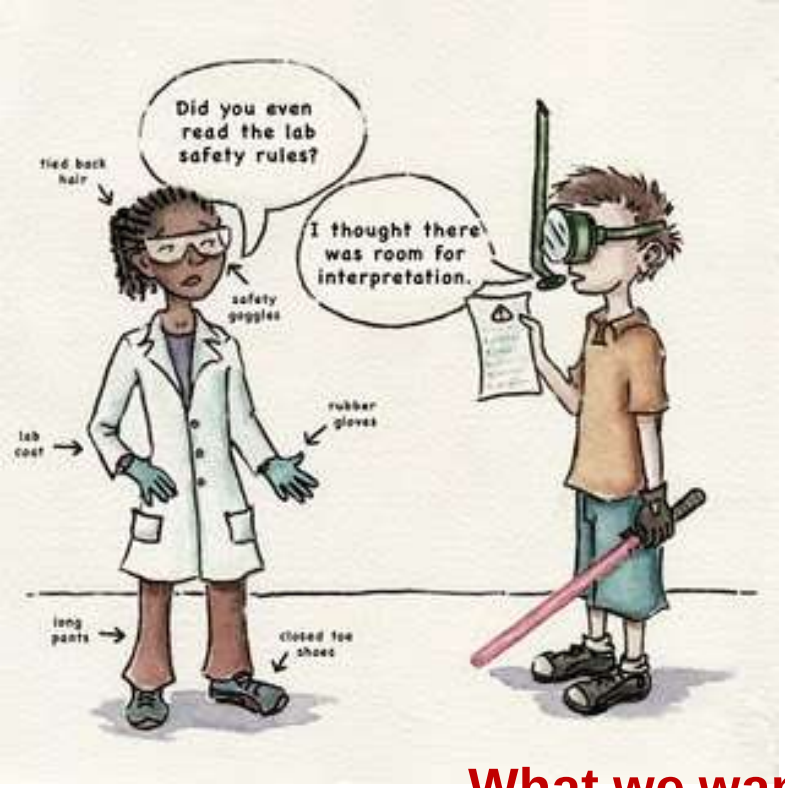








Lab safety – some more rules



- Wear appropriate clothing
  → long trousers, robust and closed shoes
- Wear appropriate PPE (safety glasses, lab coat, etc.)

What we want to avoid !

source:
http://nobel.scas.bcit.ca/debeck_pt/science/safety.htm

Overnight

Nachttafel / Overnight Experiment — Stab SGU, ETH Zürich

Nachttafel für Experimente / *Overnight Experiments*

Gebäude und Raumnummer / *Building and room number*: _____

Datum und Uhrzeit *date and time*			
Beginn *start*		**Ende** *end*	
Verantwortliche Person und Stellvertreter *responsible person and deputy*			
Name *name*		**private Telefonnummer** *private phone number*	
Name *name*		**private Telefonnummer** *private phone number*	
Experiment / Reaktion *experiment / reaction*			
Beschreibung *description*			
Reaktionsgleichung *chemical equation*			
Lösemittel *solvents*			
Medien *media*	o Elektrizität *electricity*	o Kühlwasser *cooling water*	o Stickstoff *nitrogen*
Spezielle Gefahren *Particular hazards*	o o	o o	o o
Geeignete Löschmittel *Suitable extinguishing agents*	o Wasser *water*	o Kohlendioxid (CO_2) *carbon dioxide (CO_2)*	o Sand *sand*
Notfallmassnahmen *Emergency measures*			

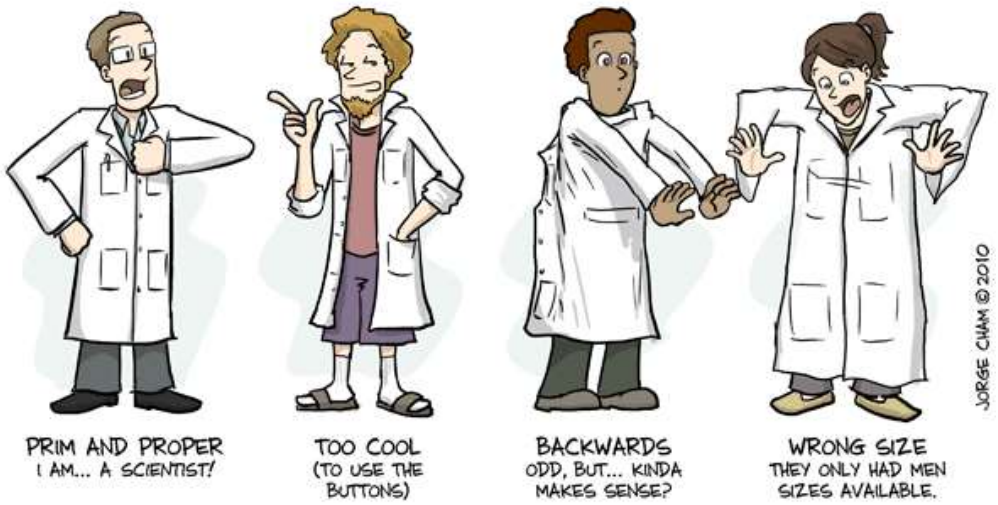
o Vakuum *vacuumy*	o sonstiges: *other:*	
o o	o o o o	

Datum und Unterschrift / *date and signature*: _____

Personal Protective Equipment

STOP: Personal protective equipment – Lab coats

- Protection of lab personnel, environment and samples
- Mandatory in all (micro-) biological and chemical labs and when handling hazardous substances (e.g. liq. N_2, special waste, etc.)
- Not allowed: at desk, in cafeteria, in offices, etc.
- To be washed regularly (for laundry service: contact SSHE)
- In biosafety labs level 2: disinfect after contamination



EYE PROTECTION

Safety goggles

- Protection of lab personnel
- Mandatory when
  - Risk of splashes / aerosol production / dust production
  - Spill cleanup
  - Handling chemicals (including solvents) or cryogenic liquids
  - Working with lasers (class 3B and 4)
  - Cutting glass
- Don‘t wear contact lenses (not even in combination with safety goggles)

→ When 1 person is doing such work in the lab, all others have to wear safety goggles, too!

Safety goggles

- Optically corrected safety glasses can be obtained via SSHE
- **Normal glasses don’t replace safety goggles!**

HAND PROTECTION

Gloves

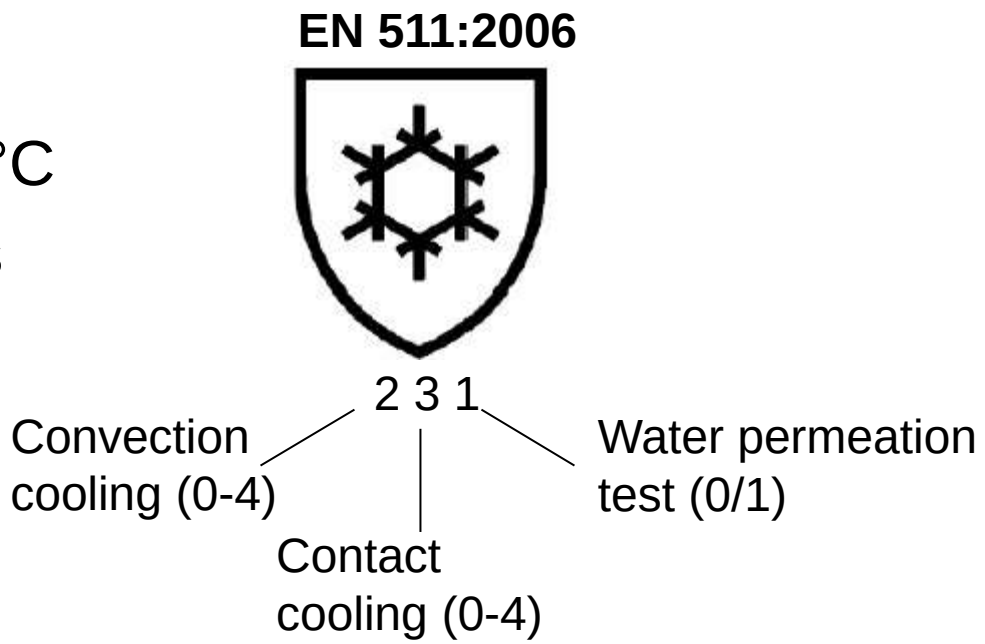
- Protection of lab personnel, environment and samples
- Regularly check and replace re-usable gloves, never re-use single-use gloves
- Mandatory when
  - contact with hazardous substances or pathogenic material cannot be excluded
  - handling cryogenic liquids (liquid N2 etc.) or dry ice

→ Replace gloves after max. 2 h, wash hands and use hand cream

COLD

Protective Gloves against Cold

- Norm EN 511: for all gloves which protect against convection cooling and contact cooling up to -50°C
- Additionally, these gloves must at least belong to performance class 1 according to norm EN 388 regarding abrasion resistance and tear propagation



Protective Gloves against Cold

Protective Gloves against Cold

Liquid Nitrogen

After the removal of the blisters

2 weeks after the incident

Source: P. Roblin, A. Richards, R. Cole, Burns **23**, 1997, 638-640

- Handling of test tubes with tongs/tweezers, which were deep frozen in liquid nitrogen – person wore protective gloves
- No direct contact with liquid N_2
- Years of working experience

CHEMICAL RISKS

Protective Gloves against Chemical Risks

- Waterproof, only little protection against chemical risks; NOT «resistant against chemicals»
- Good degradation and penetration characteristics, protects against permeation by chemical substances
  - Degradation: durability, soaking
  - Penetration: A chemical substance penetrates a damaged spot in the material / porosity, through leaking stitching (macroscopic permeation)
  - Permeation: A chemical permeates the material of the glove on a molecular level

    breakthrough time (min – h)

Requirements for gloves

- **Aim:** Unimpaired working performance and, at the same time, highest possible protection
- Ergonomic fit
- High-quality materials
- Practice-oriented in terms of tactility, grip, skid resistance, «interior climate»
- Durability, lifetime

Protective Gloves against Chemicals

- Glove considered resistant to chemicals, when it reaches a protective index of at least class 2 against three of the twelve test substances
- **Test substances**

  (A) Methanol, (B) Acetone, (C) Acetonitrile, (D) Dichlormethane, (E) Carbon disulfide, (F) Toluene, (G) Diethylamine, (H) Tetrahydrofurane, (I) Ethyl-acetate, (J) n-Heptane, (K) NaOH 40 %, (L) H_2SO_4 96 %

- **Protective index according to EN 374-1**

breakthrough time		breakthrough time	
Class 1	> 10 min	Class 4	> 120 min
Class 2	> 30 min	Class 5	> 240 min
Class 3	> 60 min	Class 6	> 480 min

Protective Gloves against Chemical Risks

Protective Gloves against Chemical Risks

Comparison of Different Glove Materials

	Nitrile 	Latex 	PVA 
Water	Good resistance	Good resistance	Weak resistance
Acetone	Weak resistance	Medium resistance	Weak resistance
Trichlorethylene	Weak resistance	Weak resistance	Good resistance
NaOH, 40%	Good resistance	Good resistance	Weak resistance
Toluol	Medium resistance	Weak resistance	Good resistance

Chemical Resistance

NitroChem Plus

	Breakthrough time in minutes	Protective index 0-6
Ethanol	8	0
Ethidium bromide in H_2O	> 480	6
Ethyl acetate	< 1	0
Formaldehyde 35%	> 480	6
Gasoline	84	3
Glutar dialdehyde	> 480	6
Heptane 98% + 1-Butanol 2%	9	0
Hexane	> 480	6
HCl	126	4

Sources of Information

- Safety data sheet
- GESTIS Substance Database
  - http://gestis-en.itrust.de/nxt/gateway.dll?f=templates$fn=default.htm$vid=gestiseng:sdbeng
- http://www.ansell.com
- http://kcl.de
- http://www.mapa-professionnel.com

Acetone (MSDS) – protection of hands

Wear protective gloves

Material of gloves

Butyl rubber, thickness: 0,7 mm
The selection of the suitable gloves does not only depend on the material, but also on further marks of quality and varies from manufacturer to manufacturer.

Penetration time of glove material

Value for the permeation: Level ≥ 6
The exact breakthrough time has to be found out by the manufacturer of the protective gloves and has to be observed.

As protection from splashes gloves made of the following materials are suitable: Natural rubber

Gloves

- To be removed before
  - Working at desk / office space
  - Touching computer keyboards, door handles, telephones, etc.
  - Leaving the lab

How to remove gloves




RESPIRATORY PROTECTION

Respiratory protection: Respirators

Some basics:

- Mandatory when risk of toxic gases or chemical vapors / smoke
- All potentially exposed people have to wear one
- 2 Types:
  - Dependent on circulating air
  - Independent of circulating air

Respiratory protection: Respirators

Masks dependent on circulating air:

(A) Full face masks

(B) Half masks

source: http://www.ritz-arbeitsschutz.de/industrie/atemschutzmasken/halbmasken/index.html

source: http://www.pps-vertrieb.de/maske-sfera-silikon-vollmaske.html

source: http://www.ace-markenshop.com

source: http://www.schutzbusshop.de/Moldex-Halbmasken-Set-8982-mit-A1B1E1K1-P3-R-D-Filter

Respiratory protection: Dust Masks

Some basics:

- Mandatory when risk of hazardous dusts / aerosols
- All potentially exposed people have to wear one
- Doesn't protect against chemical vapors or toxic gases
- Doesn't protect against lack of oxygen
- Doesn't replace a fume hood!
- Surgical masks ≠ dust masks!

Dust Masks

Surgical face mask (*no FFP class*)

Filter classes:

3 classes according to European standard EN149:2001(2009)

Filter class	Penetration limit (@95L/min air flow)	Inward leakage rate
FFP1	> 80%	< 22%
FFP2	> 94%	< 8%
FFP3	> 99%	< 2%

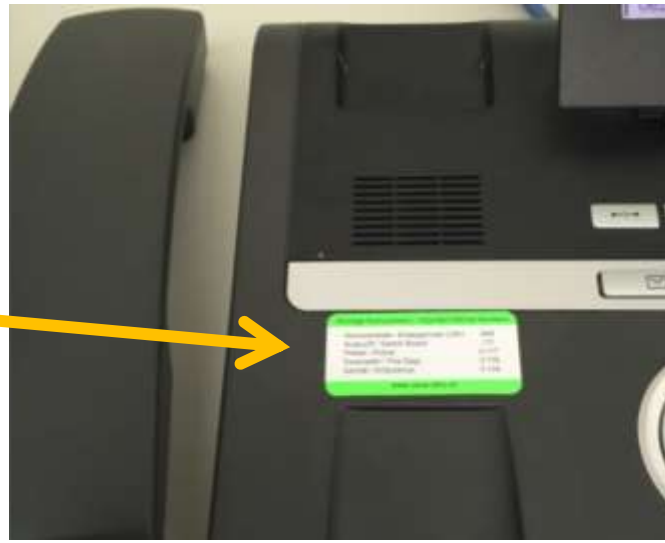
Make sure the dust mask suits you
(not only filter class is important)

FFP 3: different mask types

Emergencies - How to react

Emergency Numbers

Important emergency numbers on all ETH-phones



ETH Emergency Desk (24/7):

from internal phones: **888**

from external phones: **044 342 11 88**

External services
(0)118 fire brigade
(0)144 ambulance
(0)117 police

Intoxication
(0)145 Tox Center (councelling)

Possible Emergencies

- Accident
- Fire

Accident


Unfall – was tun?
Accident – how to react?
1. Verletzungsart > Alarmieren
Kind of injury > Call 'S.O.S.'
Immer 888 always
Schwerer Unfall
Severe accident
0-144
Vergiftung
Poisoning
0-145
2. Nothilfe leisten
First Aid
Alle Notfälle / All emergencies: 888
ETH Zürich / Sicherheit, Gesundheit und Umwelt (SGU) / www.sicherheit.ethz.ch

Alert (phone)

- **Where** did it happen?
- **What** did happen?
- **Who / How many** is / are involved?
- **When** did it happen?
- **How** did it happen?
- **What else** could be important?
- **Who** is calling?

First Aid

- First-Aid-Zip-Bags
  - in corridors / staircases
- Eye showers
- Emergency showers
- Help the internal First-Aid-Team

Eye showers

Key Rules

- First priority: Always YOUR OWN SAFETY!
- Stay calm, call 888
- Secure the area
- Apply first aid & wait for ETH first aid team
- Give necessary information to emergency services (but to nobody else!) → no contact to media!
- Do not walk around → avoid contamination
- Do not clean the area where the accident happened → might be evidence !

Fire


Feuer – was tun?
Fire – how to react?
1. Alarmieren
Call 'S.O.S.'
888 und
0-118
2. Personen retten
Rescue all people
3. Türen schliessen
Close all doors
4. Brand bekämpfen
Fight the fire
Alle Notfälle / All emergencies: 888
ETH Zürich, Abt. Sicherheit / safety@su.ethz.ch / www.sicherheit.ethz.ch

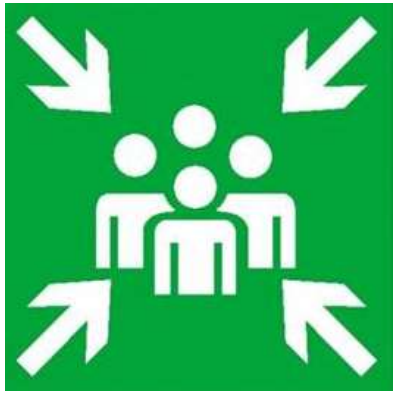
Alert (phone / fire alarm button)

- **Where** did it happen?
- **What** did happen?
- **Who / How many** is / are involved?
- **When** did it happen?
- **How** did it happen?
- **What else** could be important?
- **Who** is calling?

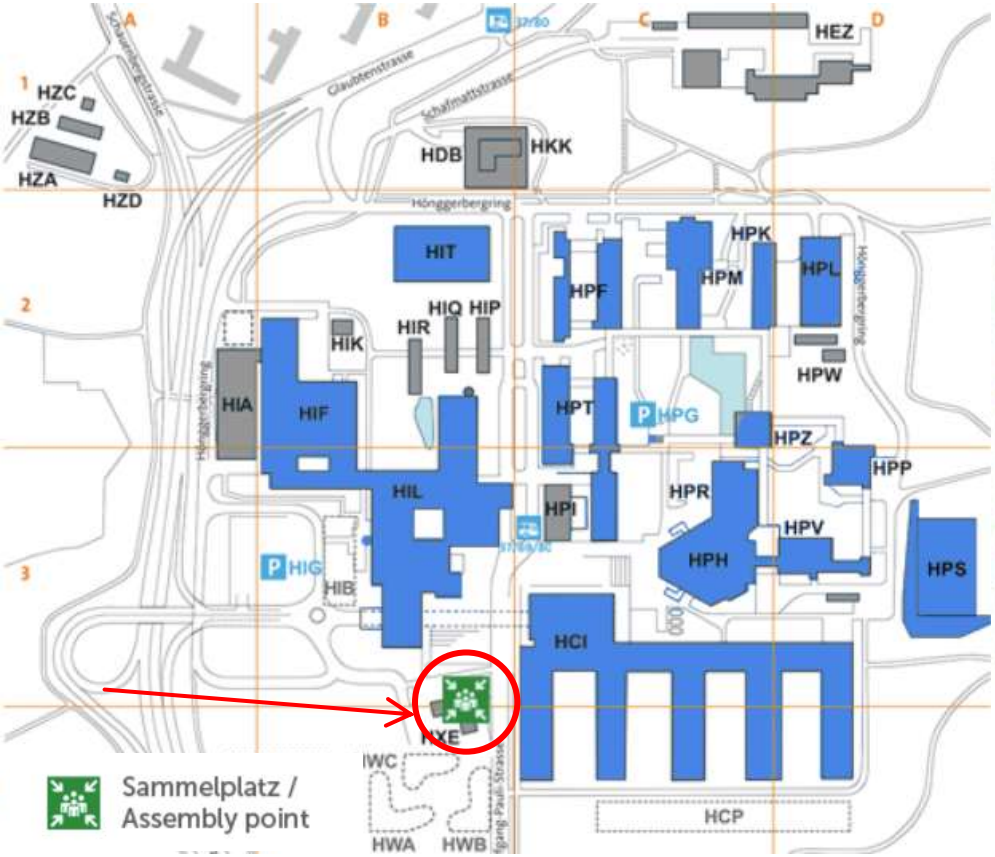
Rescue People, Close all doors

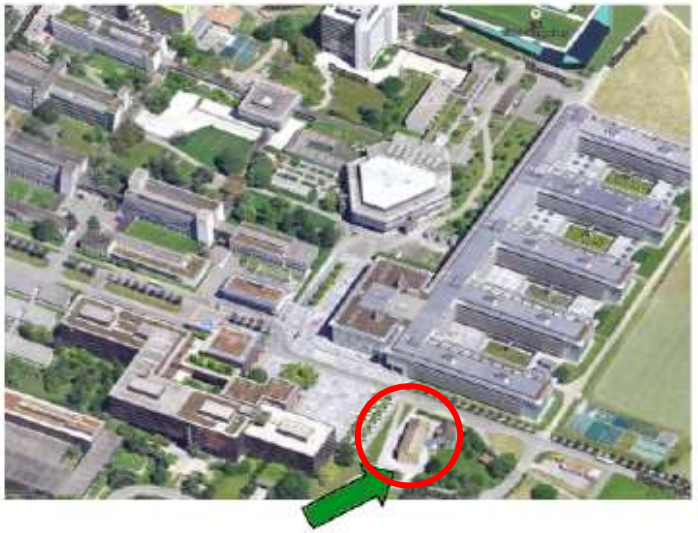
- Leave the building immediately
- Close doors!
- Go to Assembly Point
  - Hönggerberg: HXE
  - Zentrum: ASVZ-Sporthalle

Assembly Point ETH Hönggerberg

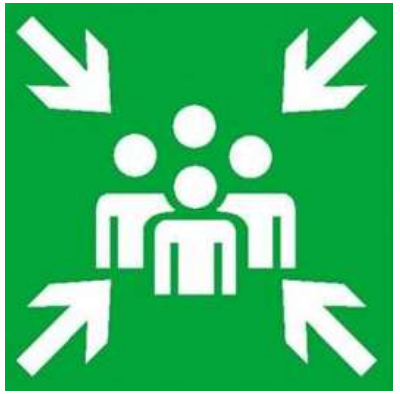


- In front of building HXE

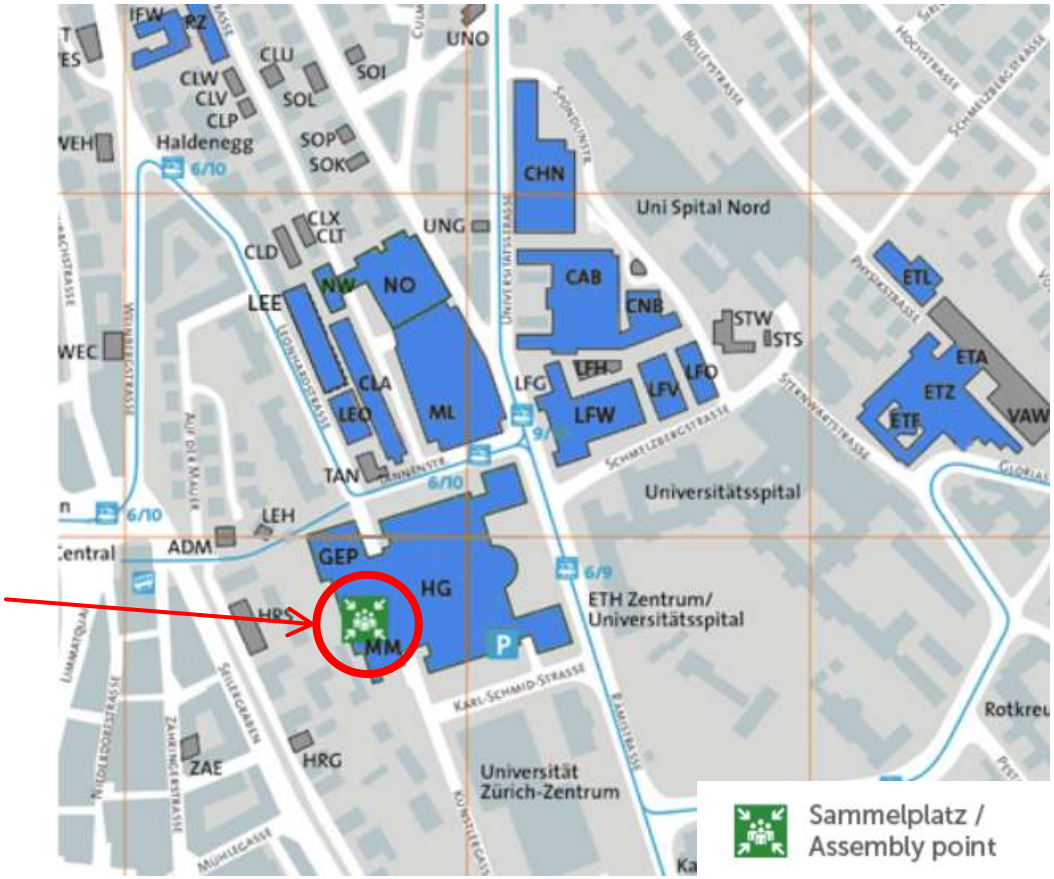




Assembly Point ETH Zentrum



- In ASVZ – Sporthalle



Fight the fire

- **First priority: Always YOUR OWN SAFETY!**
- Fire fighting training every autumn organized by SSHE
- Fire fighting equipment in the corridors
  - Extinguishers
  - Sand
  - Fire blanket

Fire extinguishers

Further Documentation

https://www.ethz.ch/services/de/service/sicherheit-gesundheit-umwelt/dokumente.html#Laborsicherheit

In Case of Emergency: Apply to Key Rules

https://www.youtube.com/watch?v=tSoHs1h0UFk

Questions